

# Alcohol and the Brain: Neuroscience and Neurobehavior

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*Twenty-five years ago, a Report to the U.S. Congress on Alcohol and Health stated, "No one knows how alcohol intoxicates" (U.S. Department of Health, Education, and Welfare 1974, p. 93). Since then, discoveries in brain science have given alcohol researchers the means to begin to understand the variety of cellular effects of alcohol and how those effects translate into behavior. These fundamental discoveries include an understanding of neurotransmitters, the chemical message carriers in the brain; the cell receptors to which the neurotransmitters dock; and the biochemical message relays that link receptor binding and the metabolism of the cell and, ultimately, brain activity.*

*Included in this chapter are highlights of some recent directions in this research, beginning with an overview on the cell-to-cell communication that underlies brain activity and that is disrupted in multiple ways by alcohol. As each section illustrates, the research effort has been aimed at dissecting the effects of alcohol down to the most fundamental level—defining what the precise chemical and molecular steps are by which alcohol slows the transmission of neural messages in the brain and how the brain responds to counter these effects.*

*As the sections in this chapter illustrate, this approach has led to a remarkably detailed, though still incomplete, picture. Effects on neurotransmitters are described with details that include the flux of charged ions into and out of the cell, the carrier molecules that shuttle neurotransmitters between neurons, the enzymes that enable or disable all this activity, and the genes that may be turned on and off in response to alcohol's presence.*

*Impressive as these discoveries have been, the challenge remains to reassemble the system and understand how the totality of effects of alcohol works in individuals. The impulse to drink too much cannot be understood in terms of one neurotransmitter any more than it can be attributed to one life event. Research on brain chemicals is one avenue to understanding how alcohol can change brain function and structure and why and how some individuals are from birth more sensitive to these effects than others. As important, this research is*

*perhaps the only way to identify pharmaceuticals that can interrupt these alcohol-based effects. However, single brain chemicals act in the context of a system that is dauntingly complex. Among the avenues scientists are exploring to address this complexity is the use of animals genetically engineered to have specific changes in neurotransmitters or in the proteins that are involved in mediating neurotransmitter responses. In this way, the effects of biochemical changes can be observed, not only in terms of chains of chemical events, but in terms of the behavior of intact animals. Even so, different neurotransmitters interact with each other; further, the absence of one key neurochemical from birth can have widespread developmental effects, and can be compensated for by other systems in the animal. For this reason, scientists are looking at the possibility of studies in animals in which several such genes are disabled—or in which the genes can be turned on and off in specific tissues or at specific times.*

*While the disassembling of the alcohol response is already providing clues to how those at risk might be identified and how alcoholism might be treated medically, future research also will require understanding all the component parts as a system that does not preordain behavior, but to some degree, sets the stage.*

## Reference

U.S. Department of Health, Education, and Welfare, National Institute on Alcohol Abuse and Alcoholism. *Second Special Report to the U.S. Congress on Alcohol and Health*. DHEW Pub. No. HSM-72-9099. Rockville, MD: U.S. Department of Health, Education, and Welfare, National Institute on Alcohol Abuse and Alcoholism, 1974.